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Evolutionary-Based Aero-Structural Optimization of a Joined Wing UAV Using Advanced Potential Methods

E. Iuliano[1], D. Quagliarella[1], P. L. Vitagliano[1], G. Andreutti[1], P. Caccavale[2], C. de Nicola[2]

[1] CIRA
Via Maiorise 81043, Capua (CE)
e.iuliano@cira.it, d.quagliarella@cira.it
p.vitagliano@cira.it

[2] "Federico II" University of Naples
Piazzale Tecchio 80125, Napoli (Na)
paolo.caccavale@gmail.com,
denicola@unina.it

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ABSTRACT

Modern UAV design require aerodynamic and structural concepts which can be quite far from conventional. The wing shapes and configurations have to be designed to allow for payload maximization and improved control characteristics. Joined wing is a well proven design solution as it matches favorable features like induced drag reduction, directional stability and static aero-elastic behaviour improvement. The present study is focused on the design optimization of such a configuration through a multi-objective genetic algorithm: this strategy has shown to be effective at highlighting the possible trade-off which arise when facing a multidisciplinary problem [1]. The cost function is evaluated with a coupled CFD-CSD procedure at multiple design points: indeed, both cruise and ultimate loading are considered in order to match "real life" aeronautical problem. Taking into account the complexity of the geometry, the very low operating Mach number and the need for evaluating several configurations during the design process, the potential methods for aerodynamic analysis show the best balance between computational cost (mesh and solution) and accuracy. Despite of the rapidly increasing computational power, CFD-CSD approaches which rapidly simulate unsteady aerodynamic/aeroelastic phenomena on and around complex geometries at a range of flow conditions are still well-suited for optimization design. A vortex lattice method exploiting a viscous-inviscid interaction concept and an advanced panel method (PaMS) are used to compute the aerodynamic solution. The PaMS code [2] is a Panel Method Solver used to solve steady and unsteady problems, it is capable to perform complex simulations coupled to both structural and dynamics methods and/or by introducing deformations due to fluid dynamics loads; unstructured meshes with quadrilateral and triangular elements have been used in order to simplify the geometry treatment, paneling and coupling with a structural mesh. The presented application proposes a compromise between aerodynamic shape modification and structural sizing towards drag minimization, weight reduction and load alleviation.

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